Near Real Time Applications for Maritime Situational Awareness

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German Remote Sensing Data Center (DFD)

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Remote Sensing and Geoinformation of Environment
Cyprus, 04.-08. April 2016

DLR

Presentation Outline

Background

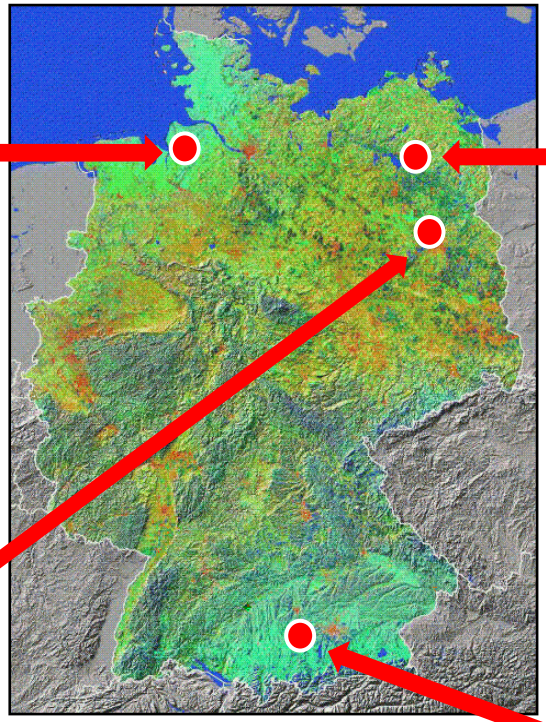
- Earth Observation Center
  - Maritime Security Lab Neustrelitz
- Component of Service Chain

Application Status and Future Development

- Ship Detection
- Oil Detection
- Wind and Wave
- Iceberg Detection and Classification

Earth Observation Center – EOC

Bremen
Maritime Security Lab



Neustrelitz
National Ground Segment
Maritime Security Lab

Berlin

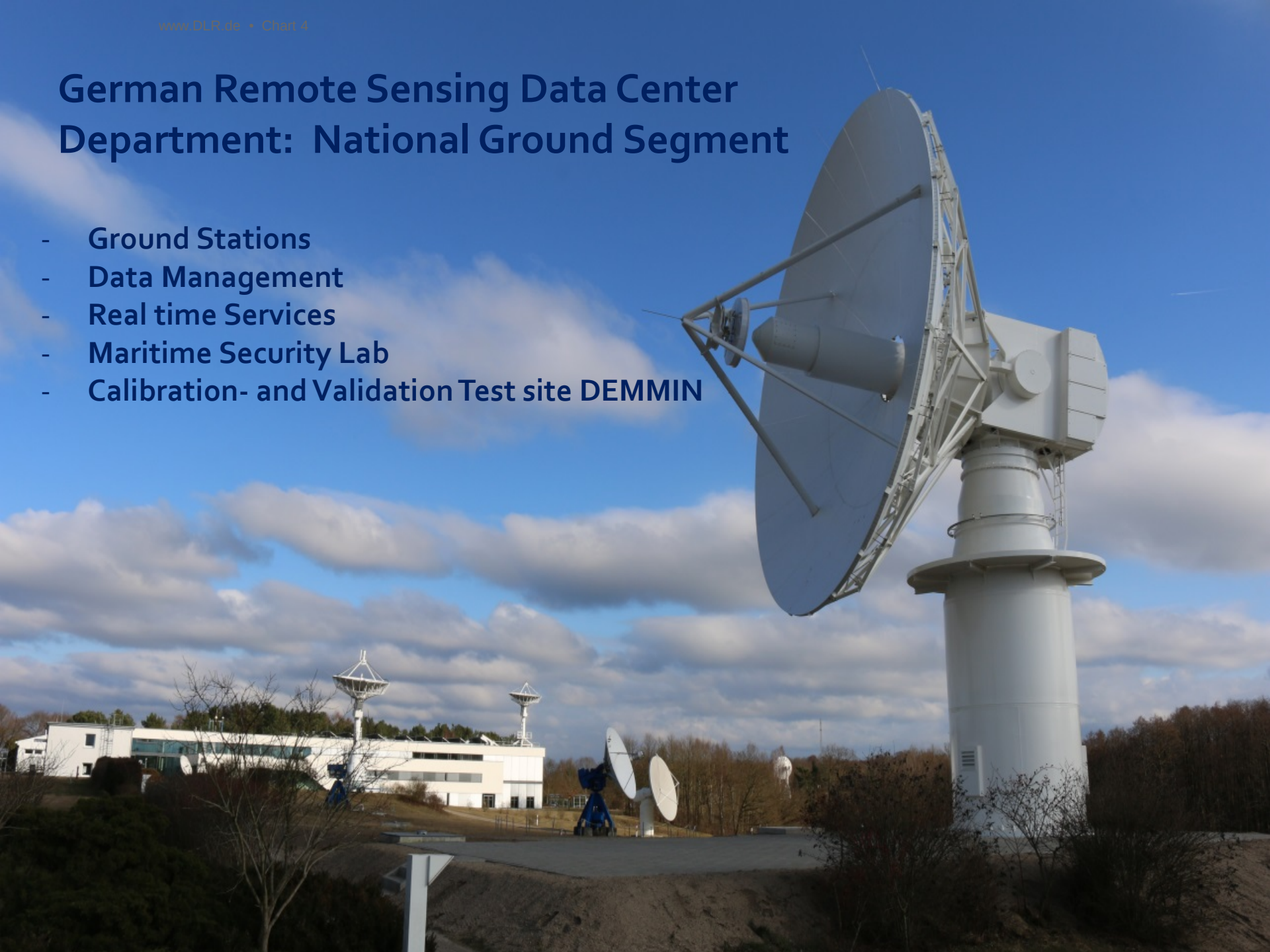
- Consists of the Remote Sensing Technology and the German Remote Sensing Data Center
- Appr. 350 employees at 4 sites
- Chairs at 2 university

Oberpfaffenhofen

DLR

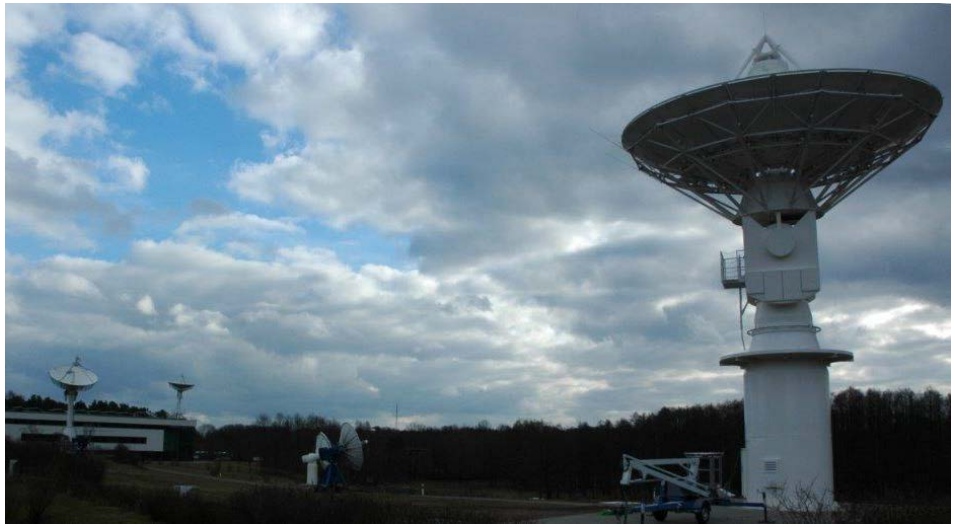
German Remote Sensing Data Center
Department: National Ground Segment

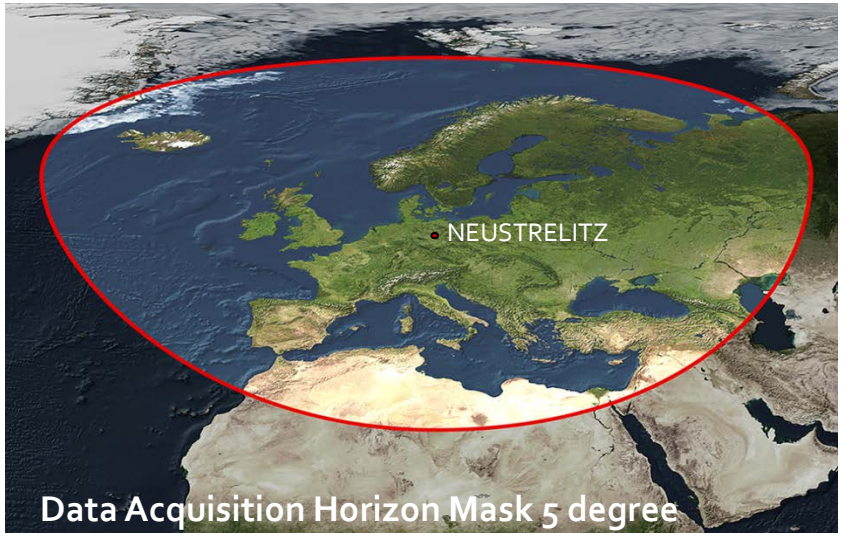
- Ground Stations
- Data Management
- Real time Services
- Maritime Security Lab
- Calibration- and Validation Test site DEMMIN



Ground Station and Processing Facility Neustrelitz

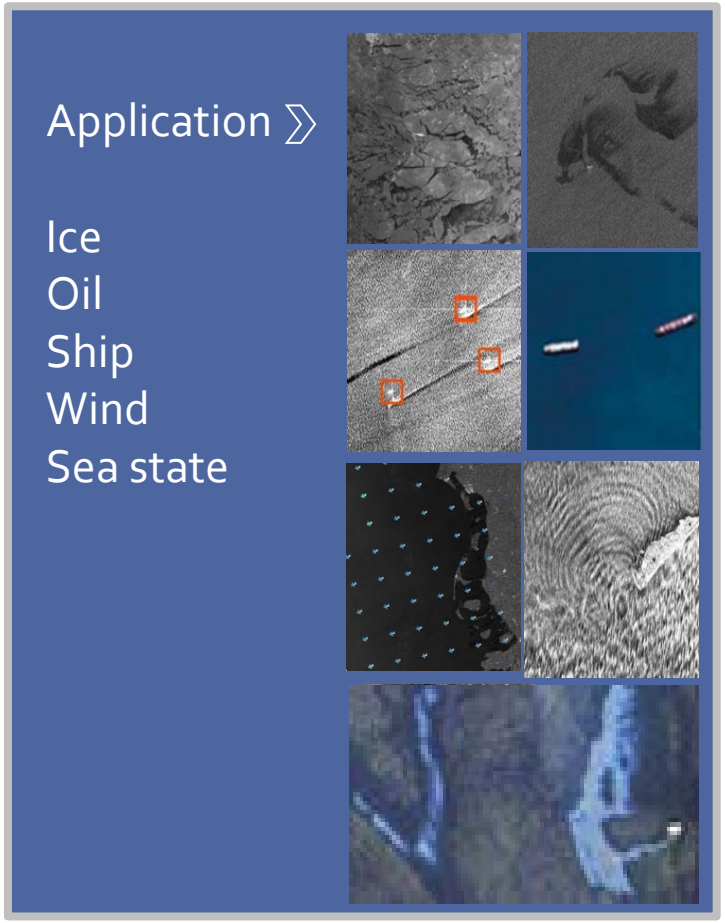
- Support of currently 12 different Satellite missions
- Main reception and processing facility for SAR Mission TerraSAR-X
- Collaborative Station for European Sentinel missions
- Radarsat-2 Regional Ground System for science purpose since Summer 2015

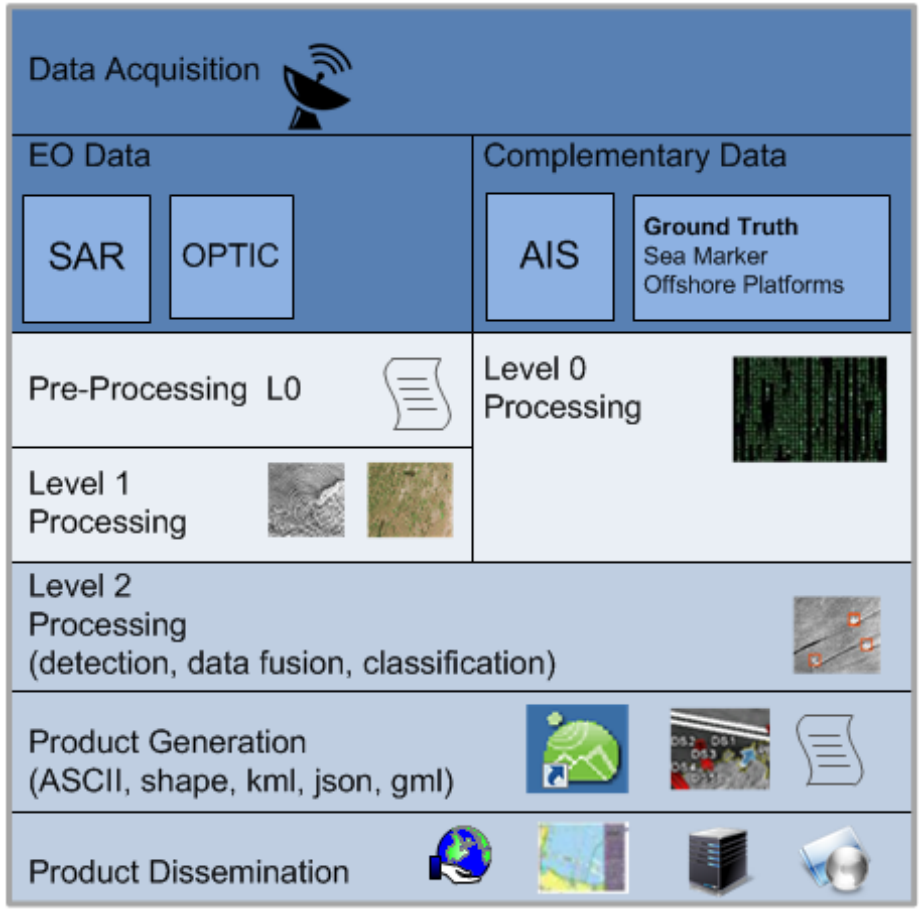




Objective

Research and development of integrated applications enabling specific value added **Maritime Information Products for the Maritime Situational Awareness** in Near Real Time





Projects

- National
  - DeMarine, Echtzeitdienste Maritime Sicherheit,
  - AWI-Polarstern Expedition (national)

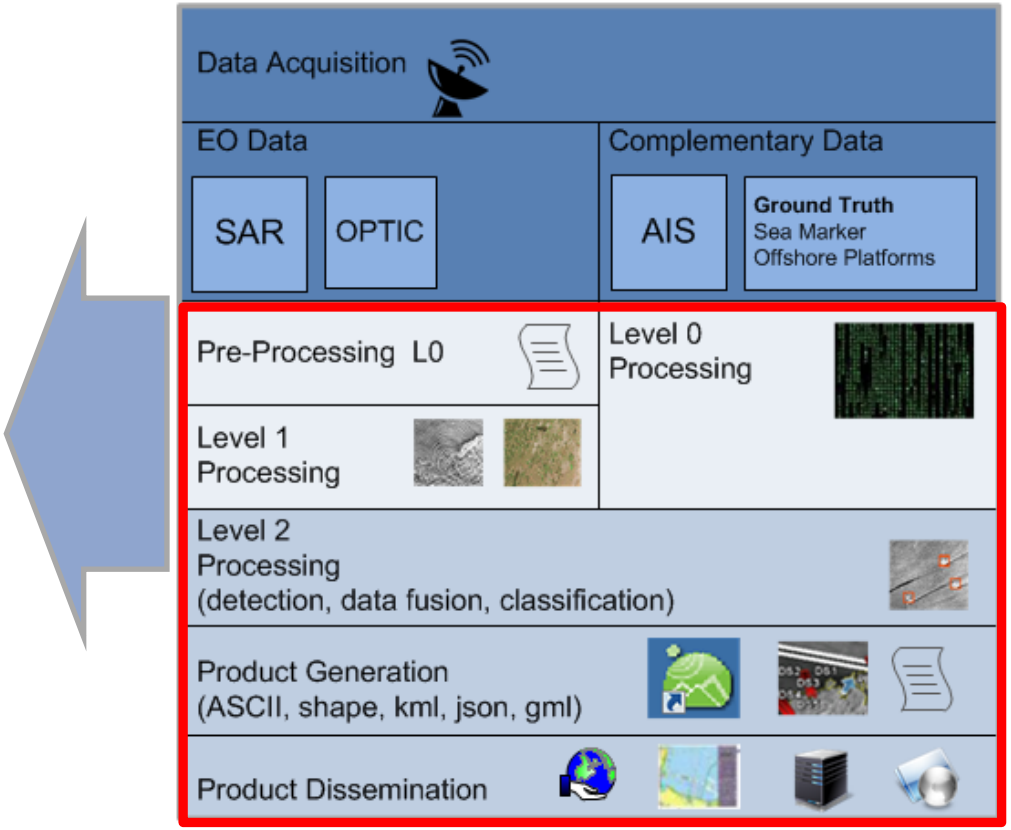
- International Projects
  - Maritime Security Services MARISS (ESA, finished 2014)
  - Development of Pre-operational Services for Highly Innovative Maritime Surveillance Capabilities Dolphin (EU FP7, finished 2014)
  - Service Activation for Growing EUROSUR's success SAGRES (EU FP7 finished 2015)
  - Optical Satellite Services for EMSA
  - JRC PMAR, PMAR-MASE (Piracy, Maritime Awareness and Risks 2013, 2015)
  - ONR, Office of Naval Research (Arctic Sea State Campaign 2015)

Objective

Research and development of integrated applications enabling specific value added **Maritime Information Products for the Maritime Situational Awareness** in Near Real Time

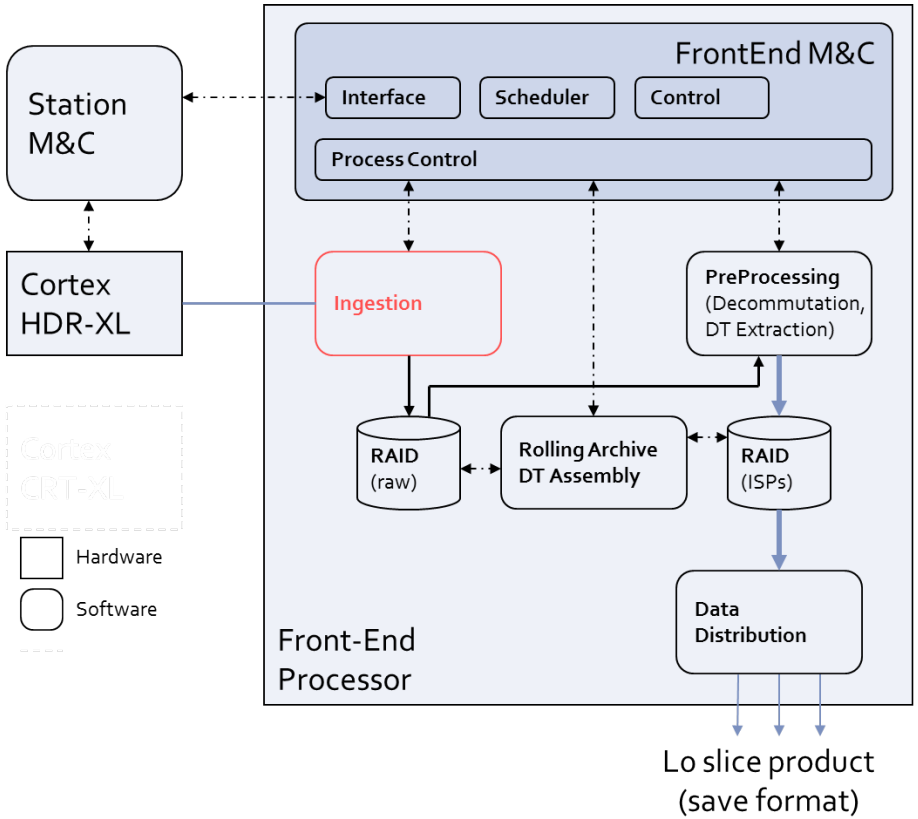
System engineering to enable…

- efficient use of the processing environment (support multi-mission approach)
- operational use of research findings
- processing of different sensors and modes
- data fusion and feature extraction
- product development
- dissemination systems development for product visualisation and operator interaction



L0 Processing
NRT – Front End Processor (Sentinel-1)

- Implementation of Ingest and Process Units
- GUI for Monitoring and Control (M&C)
- Integration into Ground Station M&C System
- Provide data quality information
- Handling of Metadata
- Development of device driver (CORTEX demodulator)
- Product generation
  - Lo processing (slicing) and distribution



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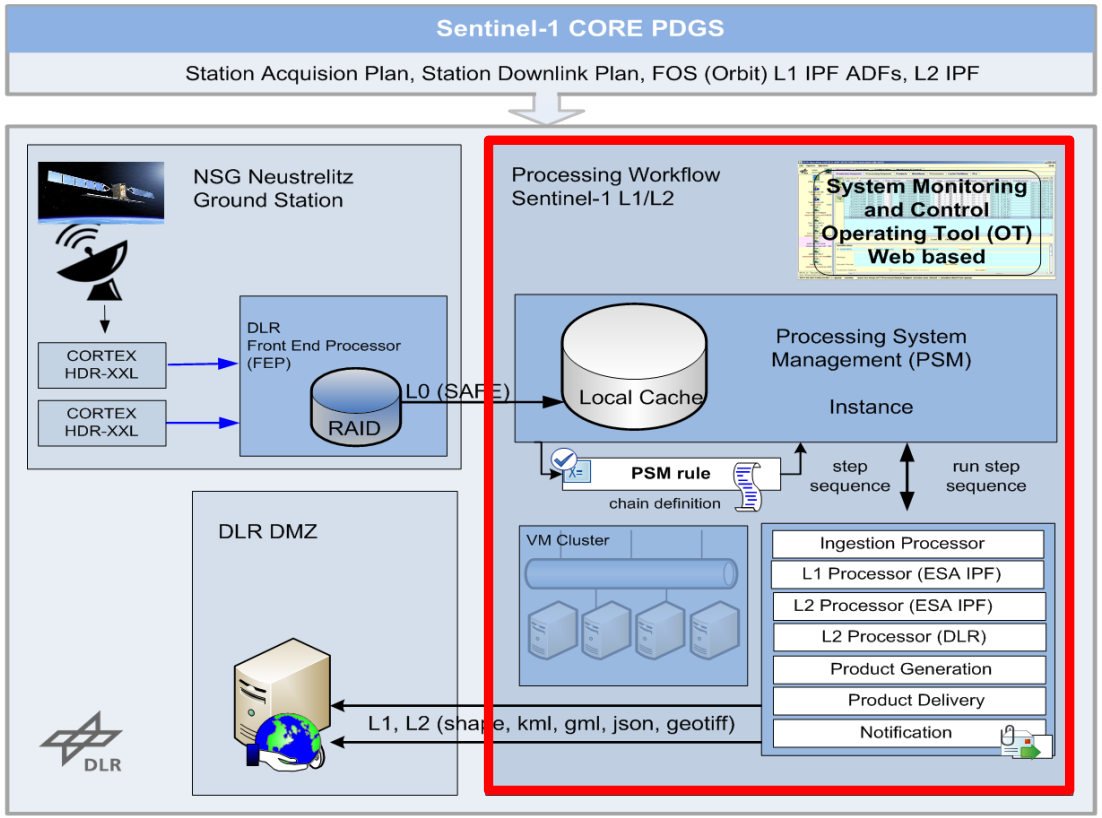
Level 1 Processing

DLR Processing System Management System (PSM)

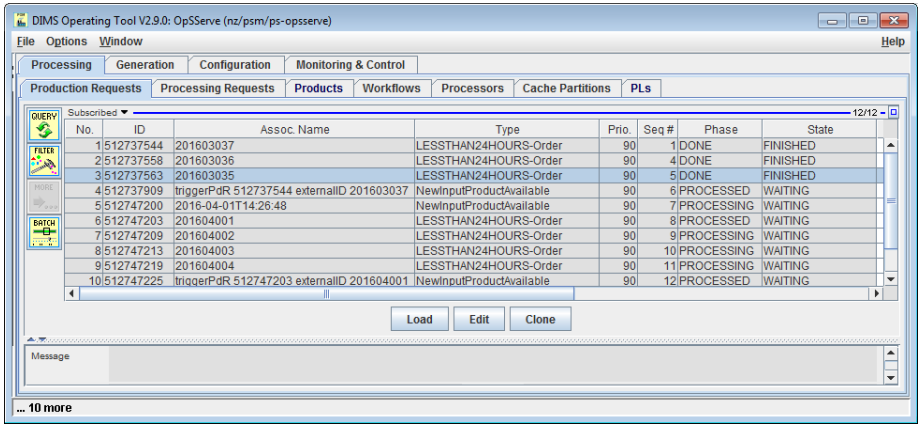
- Request or data driven workflow
- Product handling and cache management
- Development of Control System based on Processing System Management (PSM)
  - TerraSAR
  - Sentinel-1
- Integration of CORE Processor
  - TerraSAR Multimode SAR Processor TMSP
  - ESA Instrument Processing Facility IPF (Sentinel-1)

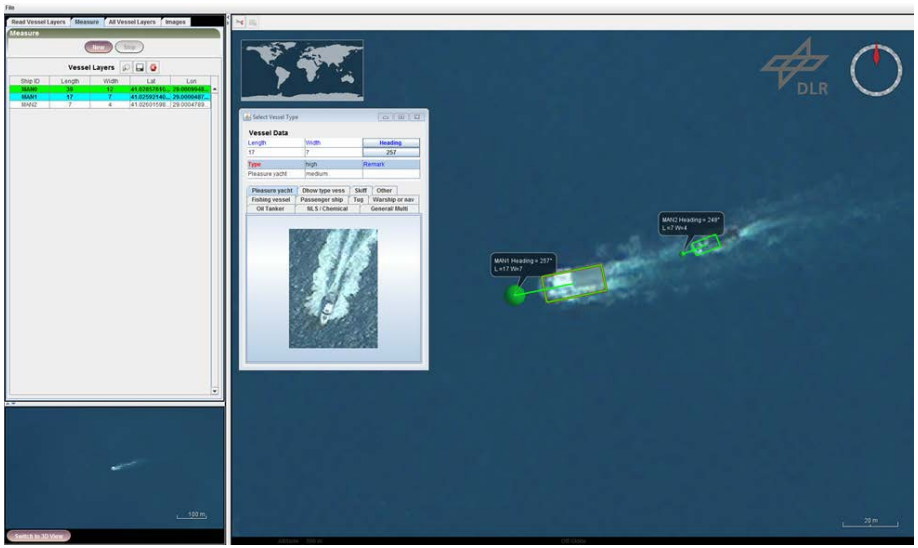


Level 2 Processing and Product Generation

DLR Processing System Management (PSM)

- Rule based
  - L2 - value adding processing (SAR, Optic)
  - Data fusion (e.g. EO-Data, Object-DB, AIS)
  - Operator Interface
- Product generation
  - L1b product (e.g. EOPO, EMSA)
  - L2 product (shape, JSON, netCDF, KMZ)



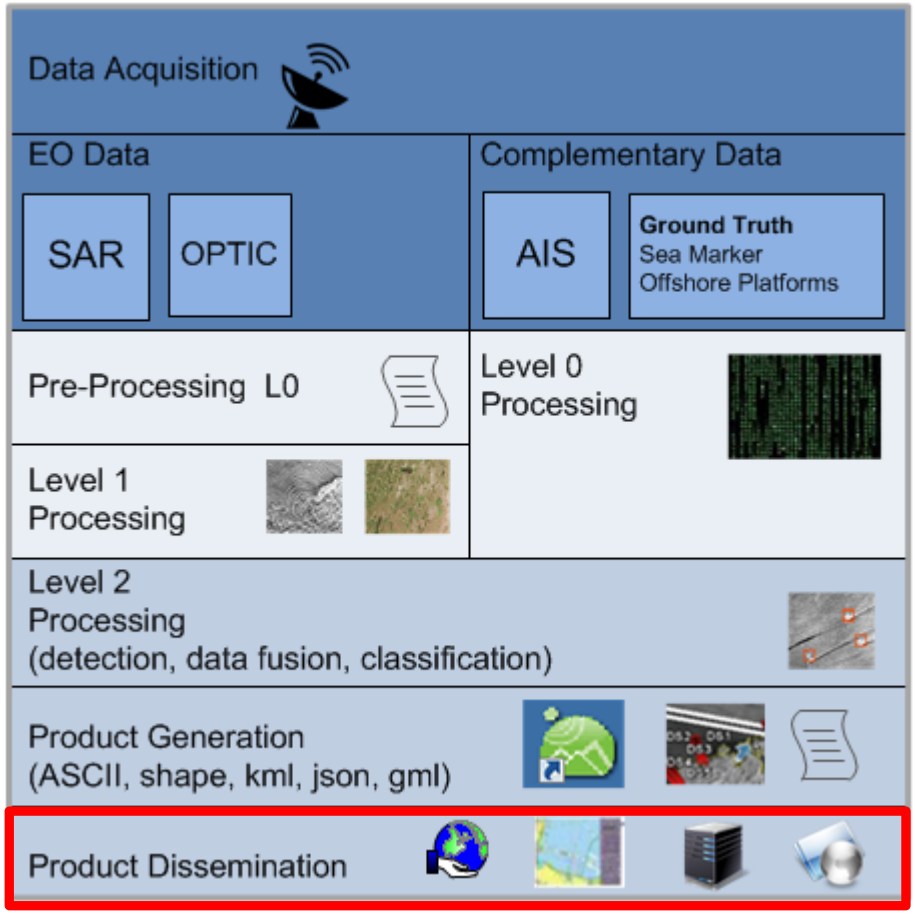


Product Dissemination

DLR Processing System Management (PSM)

- Near Real Time Delivery
  - 365/24/7 multi-mission service
  - according user requirements within 15-45 minutes

- Product dissemination
  - gridFTP,
  - ftp/ sftp
  - GeoServer
  - e-Mail



Ship- Detection Application

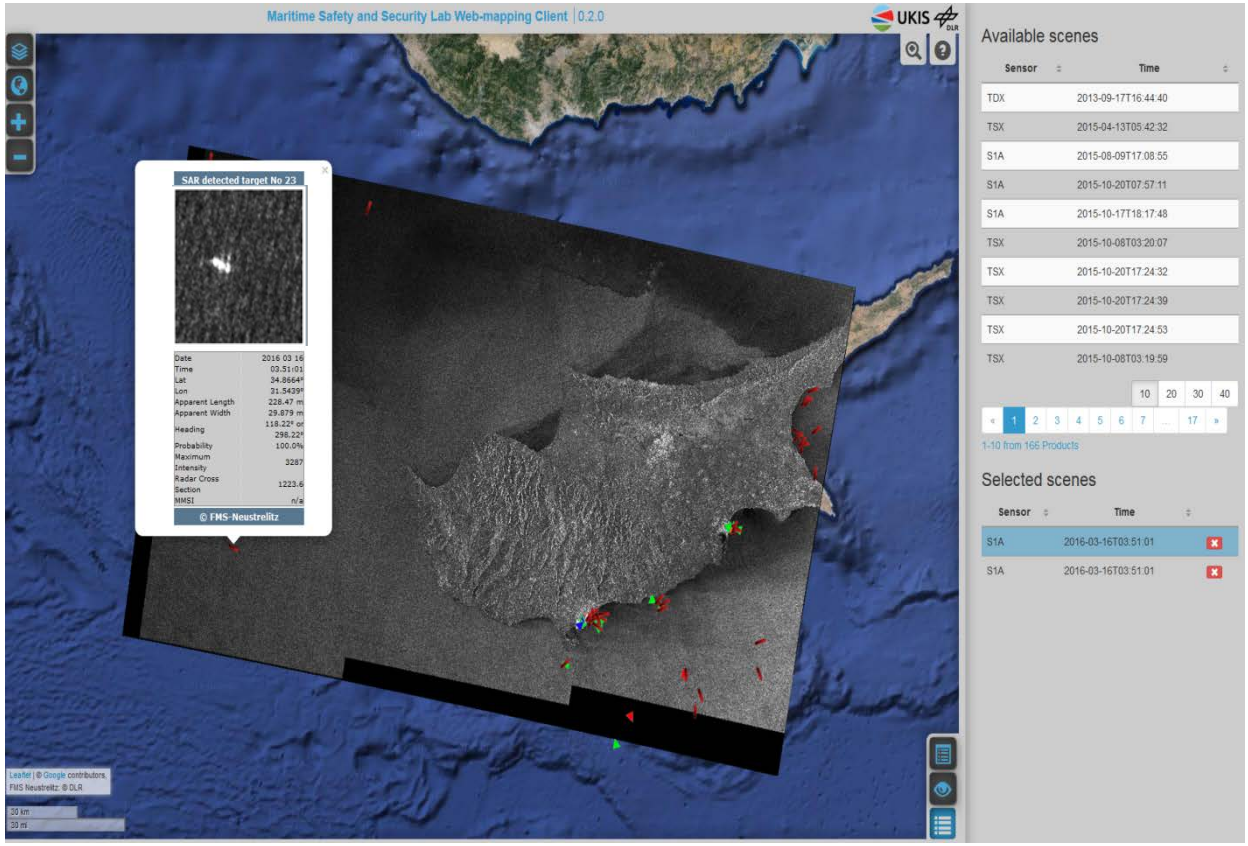
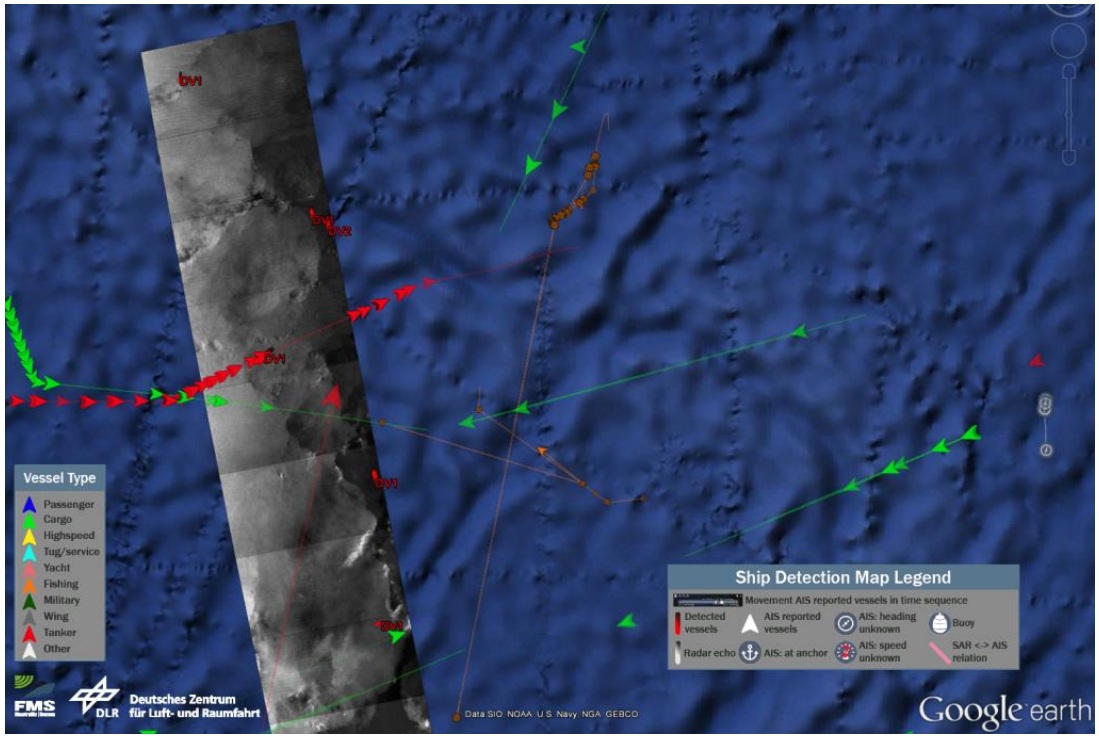


Image: S1A_IW_GRDH_1SDV_20160316T035101_20160316T035125

- Core function for SAR ship detection is the SAINT toolbox developed by the Maritime Security Lab Bremen
- Available for:
  - TerraSAR-X, TanDEM-X
  - CosmoSkyMed
  - Radarsat-2
  - Sentinel-1
- Value added products
  - **SAR/ AIS merged products** (in case of available AIS Data)
  - ASCII ; KMZ, GML; DER (EMSA); ESRI shape; json;
  - GeoTIFF (MRES_L1b; HRES_L1B)

Joint Research Center JRC
Project PMAR-MASE 2015

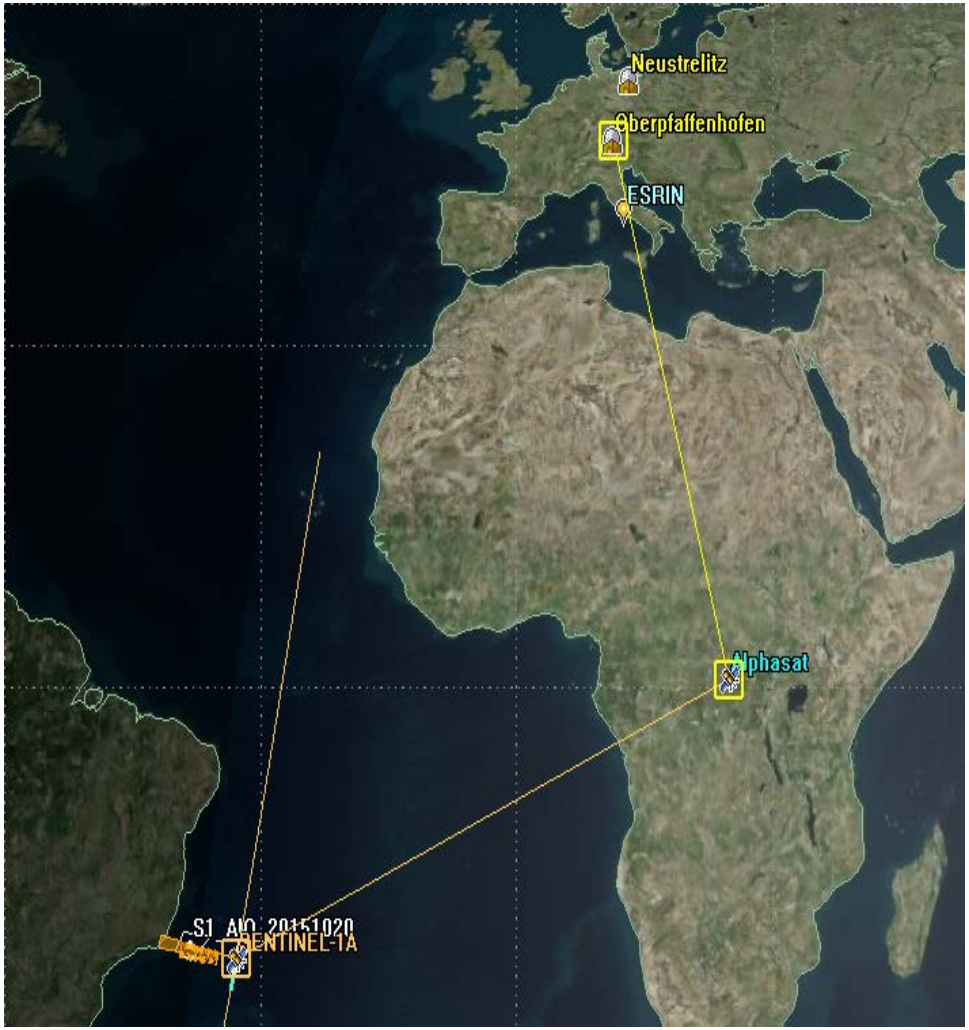


TSX1_SAR__MGD_RE___SC_S_SRA_20150809T135517

Project support during August and September 2015:

- Acquisition planning for TerraSAR-X based on the Region of Interest, defined by the project
- SAR Ship detection processing and data fusion by DLR, AIS Data provided by JRC, (Data Exchange Agreement JRC/DLR)

Application Example



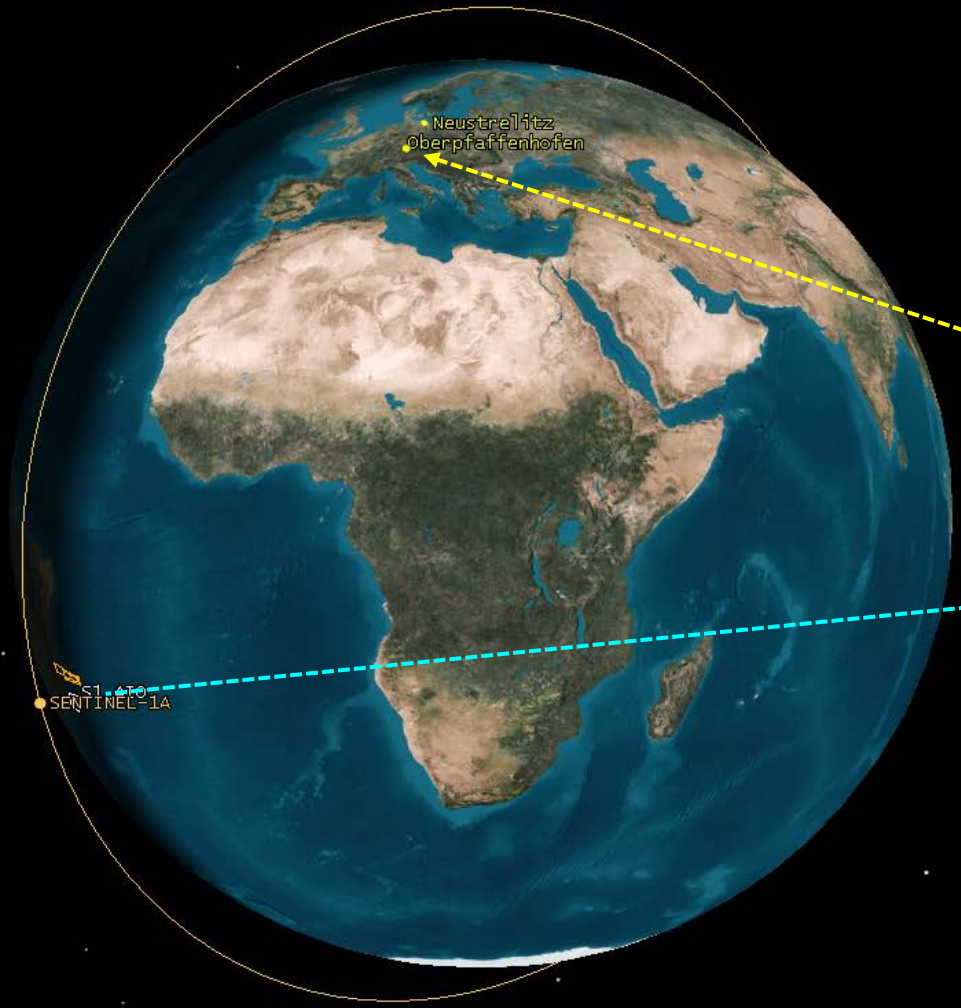
Sentinel-1 Acquisition and Downlink – Alphasat TDP-1 Test

Partners involved:

- ESA ESRIN
- ESA ESTEC
- ESA ESOC
- TESAT
- Eutelsat
- Airbus
- DLR Space Management
- DLR Earth Observation Center
  - Oberpfaffenhofen
  - Neustrelitz

LCT-Link and data reception

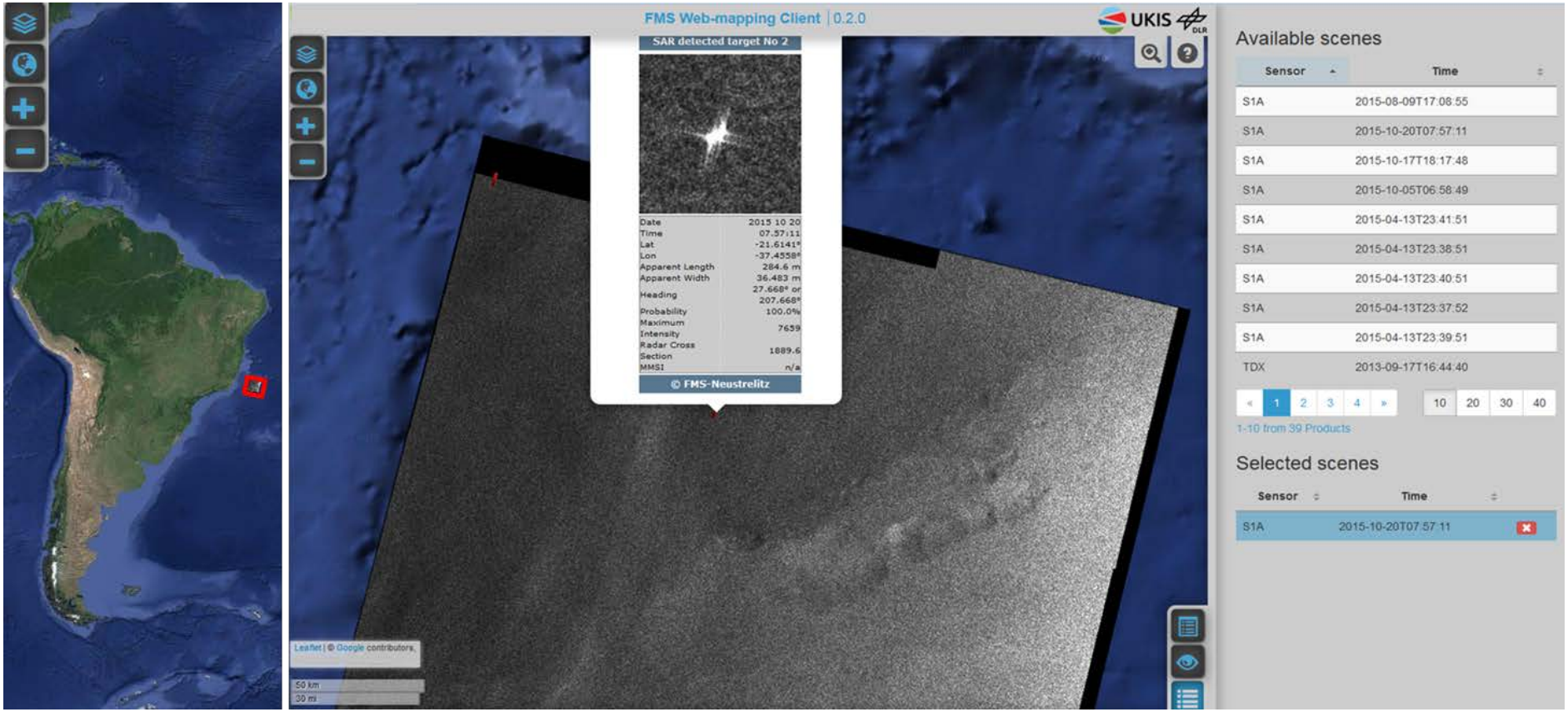
- Reception in Oberpfaffenhofen via Alphasat Ka- Band Antenna
- L0 Processing in Oberpfaffenhofen



Alphasat

- Transfer to Neustrelitz and QRT processing and automated ship detection
- End-to-End time: 18 min (further optimization possible)

Alphasat NRT Demo:
L2 ship detection product at DLR Web-mapping Client



Optical Satellite Services for EMSA OpSSERVE

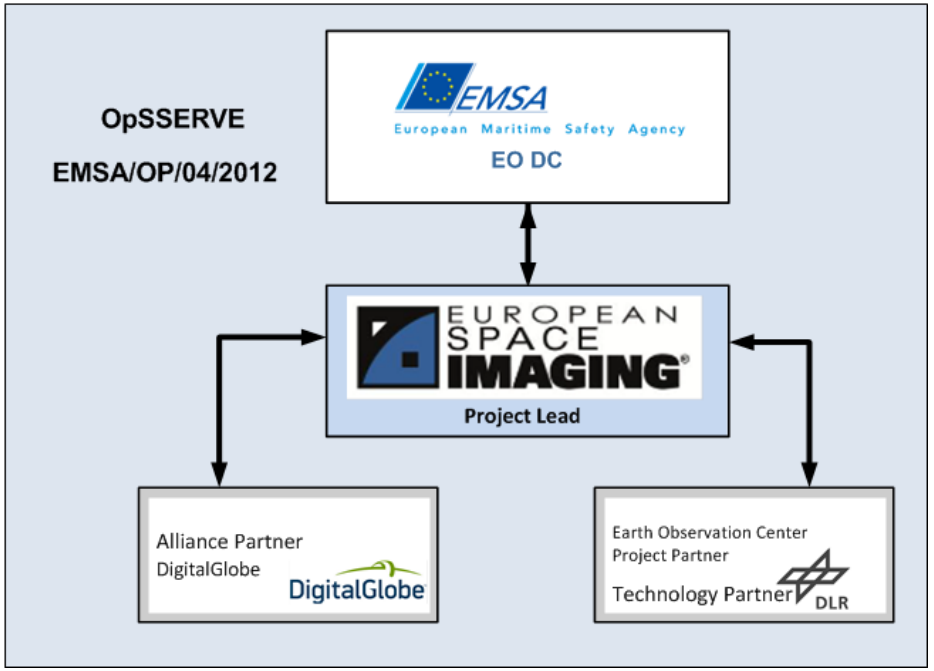
– **Service contract**:
European Maritime Safety Agency
EMSA

– project partner: **EUSI** (contractor) and **DLR** (subcontractor)

– project duration: **36 months** with the option to extend by 12 months, currently extended up to April 2016

– project start: **October 2012**

– project summary: **rapid access to satellite data and derived information** for use in maritime situational awareness



– OpSSERVE 2 Kick-off October 2015

Optical Satellite Services for EMSA (OpSSERVE)

Partners: EUSI (contractor) and DLR (subcontractor)

➢ Provision of Vessel and Activity detection service

- **optical satellite imagery (< 1m)**
  - Worldview-1; Wordview-2 (0.50m)
  - Deimos-2

NRT Delivery ≤45 min	NRT Delivery ≤3 hours

  - GeoEye-1; Worldview-1; Worldview-2; Worldview-3, Landsat-8; Deimos-2

Non NRT Delivery ≤24 hours	Archive Delivery ≥24 hours

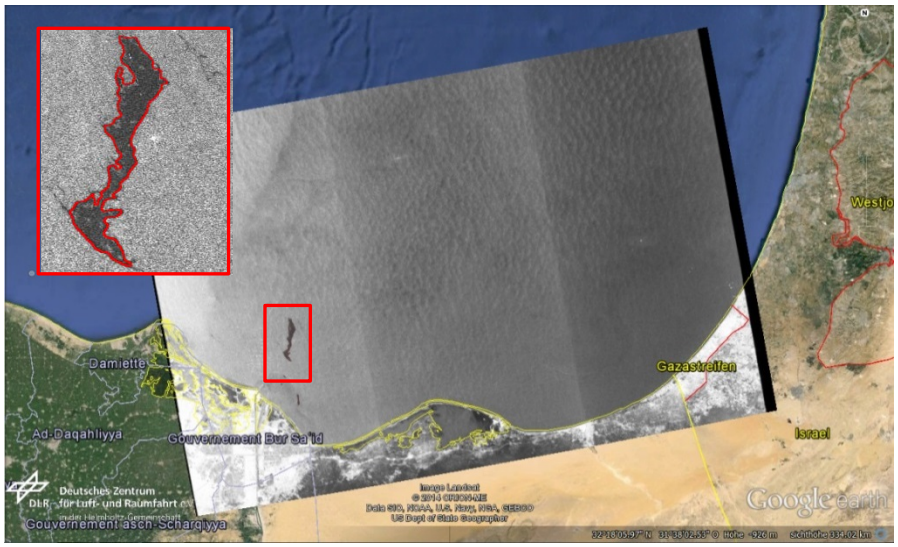
- **derived information** at sea and coast :
  - **Vessel detection**
  - **Vessel activities**

WorldView-2, Mogadishu, Somalia, 28.08.2012

skiffs

skiffs on the beach

Oil Spill Detection Application



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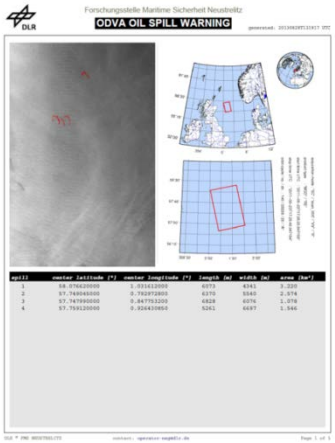
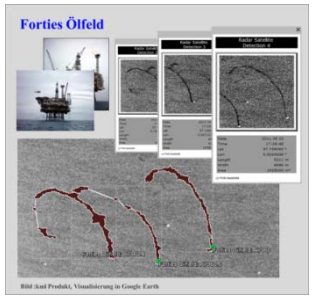
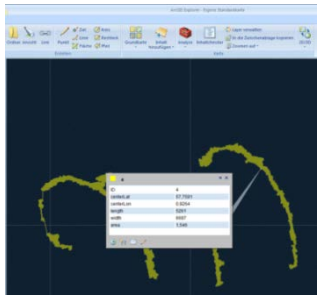






Control system implemented using the DLR Processing System Management (PSM) part of the Data Information Management System (DIMS)

- Interactive processing
- Operator interface via Virtual Network Computing (VNC)
- Automated qualification processor, Core function is the qualification algorithm developed by the Maritime Security Lab Bremen based on Neural Network (S. Singha et al.)
- Automated product delivery within 30 minutes

Application for Wind field products based on TerraSAR-X

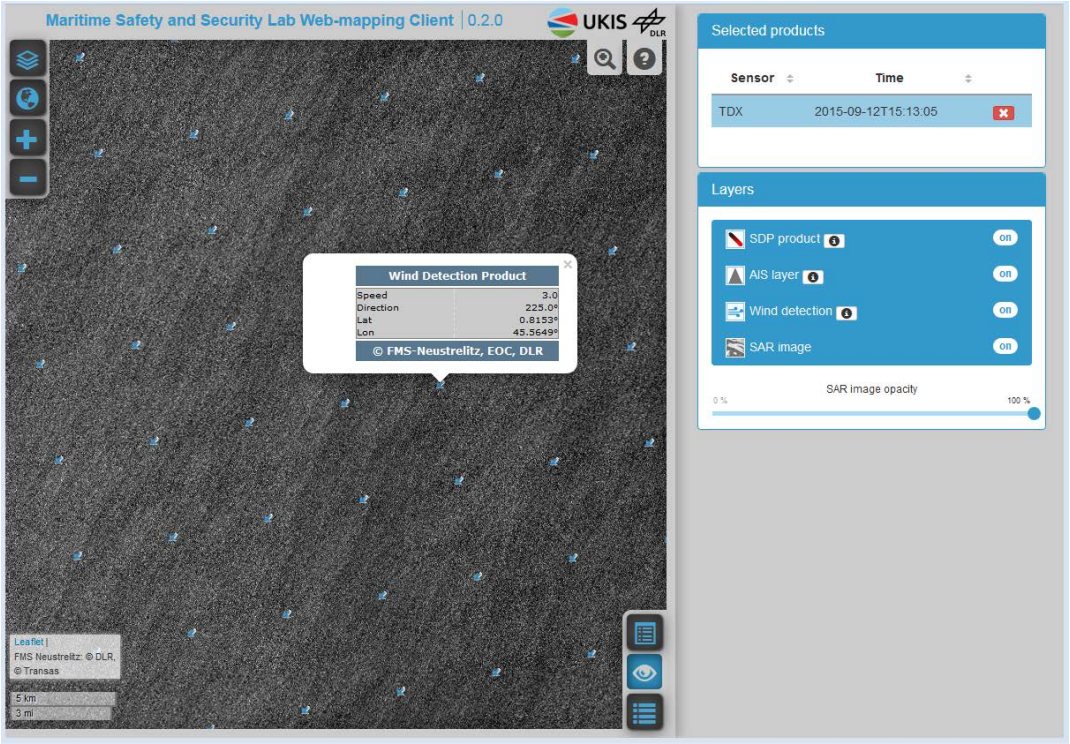


Image:
TDX1_SAR__MGD_RE___SC_S_SRA_20150912T151305_20150912T151310

The wind forecast and the Level 1 quicklook product in the background is overlaid by the DLR SAR WIND product (rectangle) derived from the Sentinel image.

- Core function is the XMOD-2 algorithm developed by the Maritime Security Lab Bremen to derive wind speed and direction, (Jacobsen et al., 2013)
- Forecast model is implemented to provide wind direction , the netCDF output is generated, containing the wind direction and intensity (WD10)
- Level 2 Produktformate
  - ASCII
  - netCDF
  - Google (KMZ)
  - png, wld, png.aux.xml
  - ESRI Shape Layer Files (shape)

Application for Wind field products based on Sentinel-1

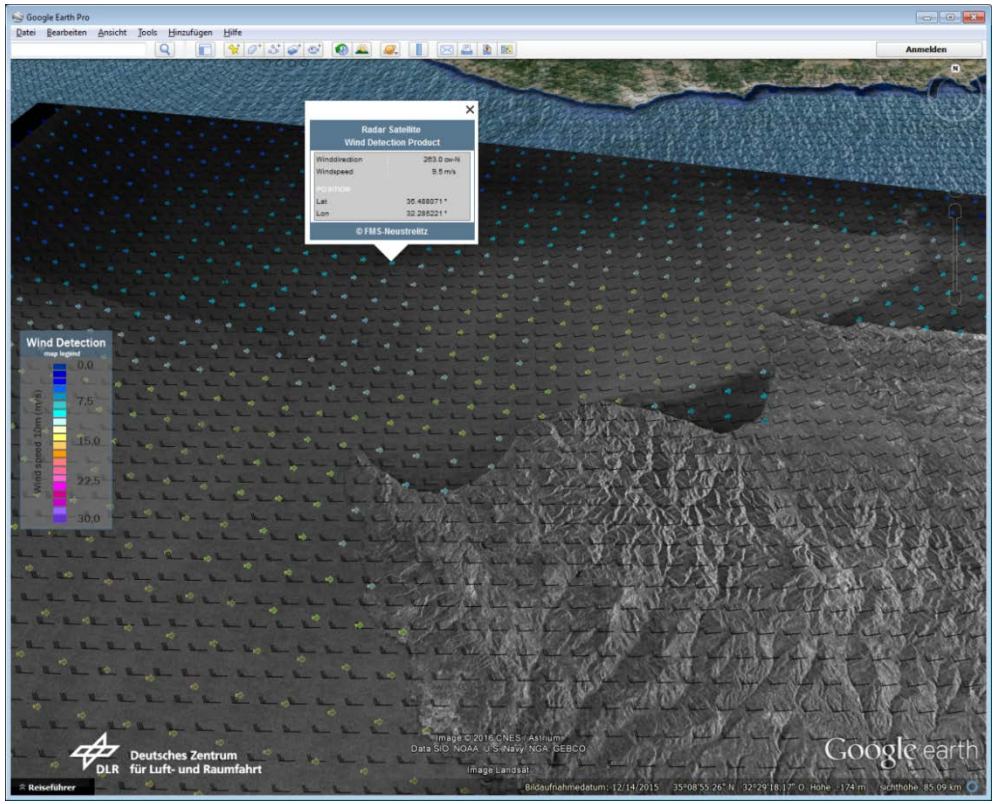
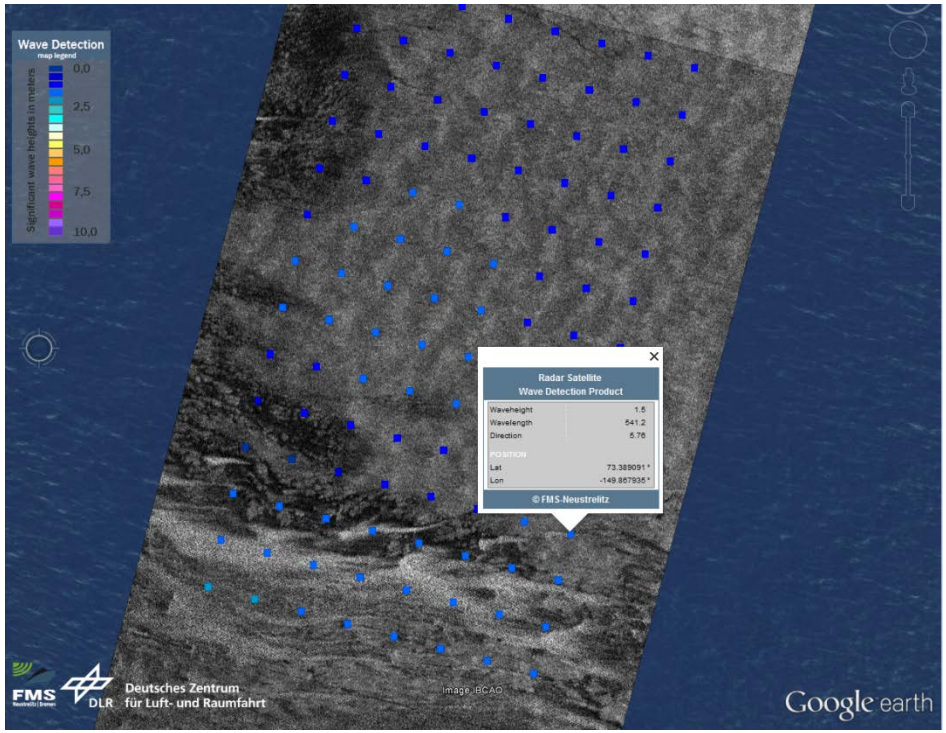


Image: S1A_IW_GRDH_1SDV_20160316T035101_20160316T035125

DLR SAR WIND product (rectangles) derived from the Sentinel image, wind forecast and Level 1 quicklook product as background.

- Core function is the CMOD-5 algorithm developed by the Maritime Security Lab Bremen to derive wind speed and direction, **validation ongoing,**
- Forecast model is implemented to provide wind direction , the netCDF output is generated, containing the wind direction and intensity (WD10)
- Level 2 Produktformate
  - ASCII
  - netCDF
  - Google (KMZ)
  - png, wld, png.aux.xml
  - ESRI Shape Layer Files (shape)

Application for Wave products based on Mission TerraSAR-X



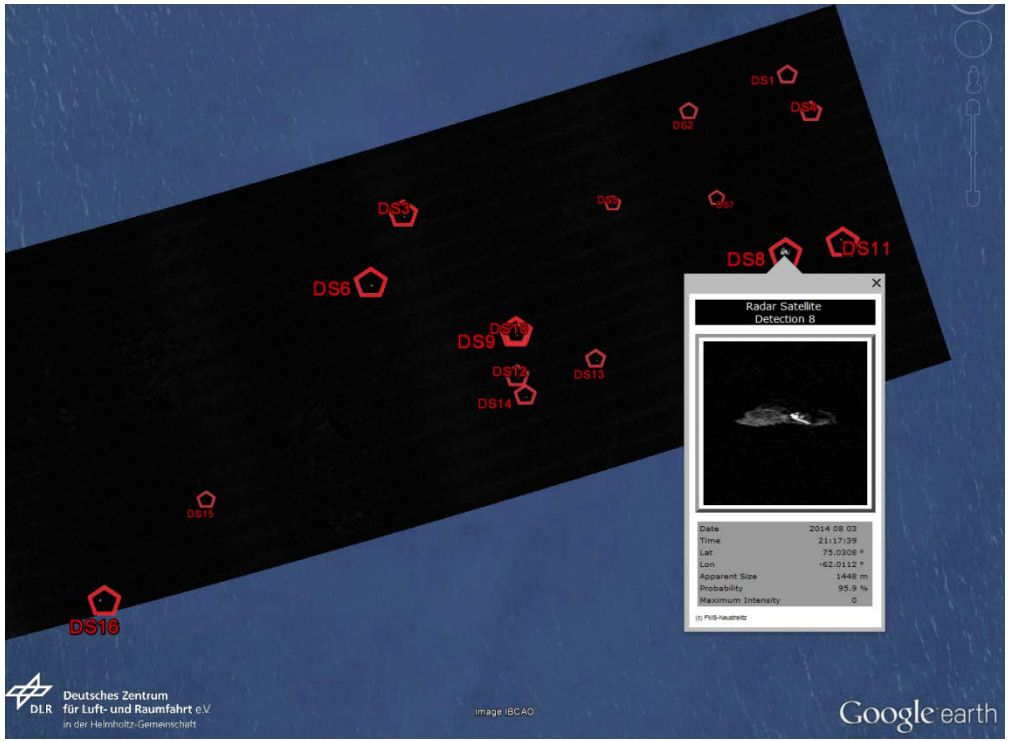
DLR SAR WAVE product (rectangles) derived from the TerraSAR-X StripMap image, L1 quicklook product as background.

- new XWAVE-2 algorithm developed by the Maritime Security Lab Bremen to derive wave height and wave length (Pleskachevsky et al., 2016)
- Level 2 Produktformate
  - ASCII
  - netCDF
  - Google (KMZ)
  - GIS, png, wld, png.aux.xml
  - ESRI Shape Layer Files (shape)

Pleskachevsky, A., Rosenthal, W., Lehner, S. (2016) Meteo-Marine Parameters for Highly Variable Environment in Coastal Regions from Satellite Radar Images. ISPRS Journal of Photogrammetry and Remote Sensing, Seiten 1-25. ELSEVIER. DOI: 10.1016/j.isprsjprs.2016.02.001. (in print)

TerraSAR-X - Iceberg- detection

- Near real time iceberg detection application to
  - Support Maritime Situation Awareness e.g. Ice Service Center
  - Support Exploration management and resource planning
  - Route management



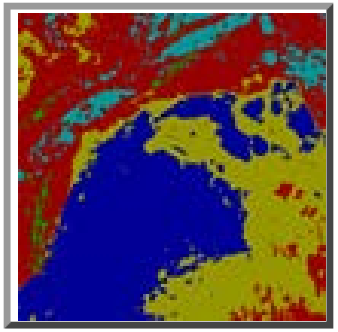
TerraSAR-X ScanSAR Mode,
Polarisation: HH, 150 km range,
acquired on 3th August 2014 at 21:17 UTC
Iceberg detection by using SAINT

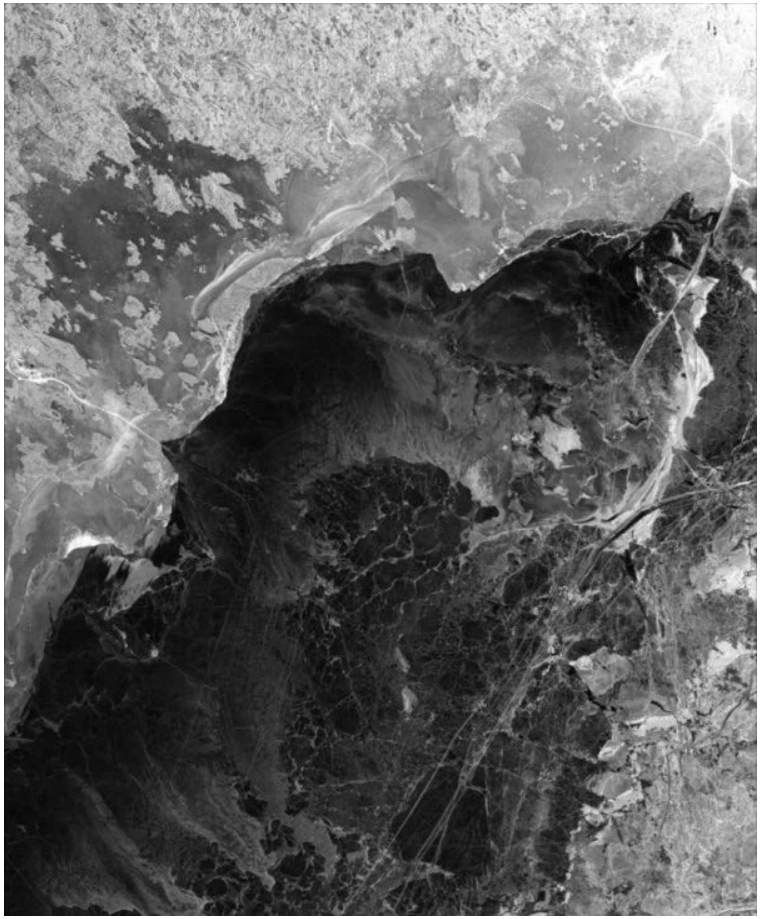
Frost, Anja und Ressel, Rudolf und Lehner, Susanne (2015) Iceberg Detection over Northern Latitudes Using High Resolution TerraSAR-X Images. In: 36th Canadian Symposium of Remote Sensing - Abstracts. 36th Canadian Symposium of Remote Sensing, 8.-11. June 2015, ST. JOHN'S, NEWFOUNDLAND AND LABRADOR, CANADA.

Ice Classification

- Currently being developed by the Maritime Security_Lab Bremen
  (Ressel, Rudolf und Singha, Suman (2016) Comparing Near Coincident Space Borne C and X Band Fully Polarimetric SAR Data for Arctic Sea Ice Classification. Remote Sensing, 8 (3), Seiten 1-27. MDPI. DOI: 10.3390/rs8030198. ISSN 2072-4292.)

- Planned value added products based on TerraSAR-X (DualPol)
  - ASCII ; png, KMZ,
  - ESRI shape;
  - ECDIS (S411) Ice Chart





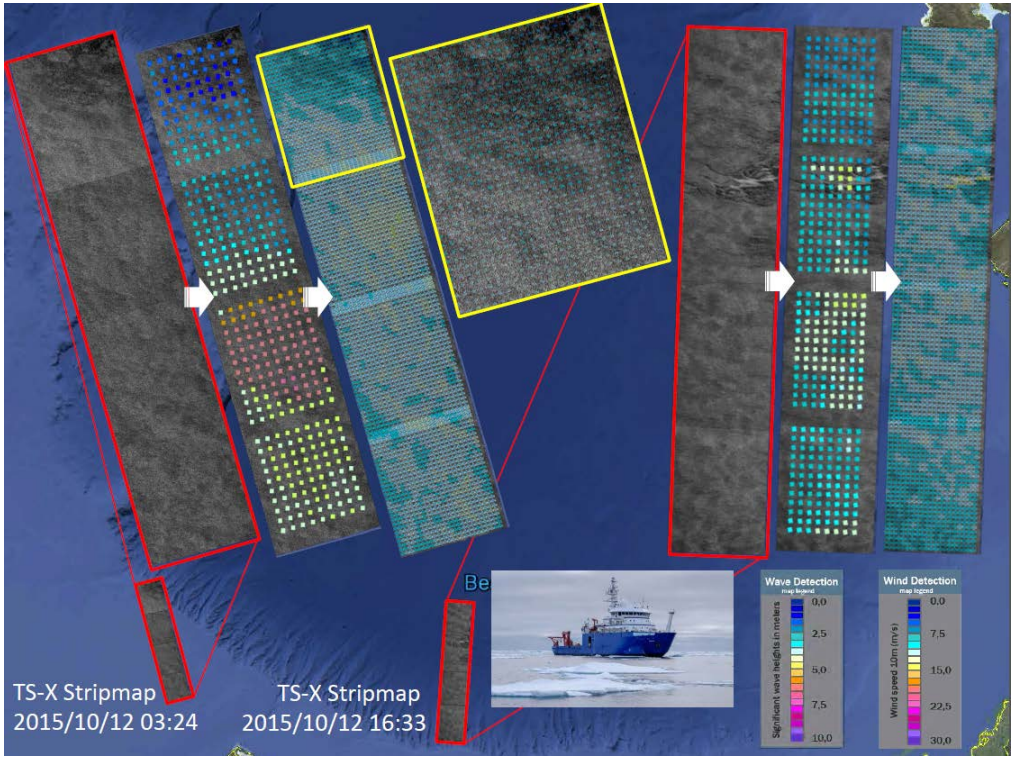
NRT Support for Office of Naval Research (ONR) Arctic Sea State Campaign 2015

Research Vessel Sikuliaq
Beaufort Sea

http://www.apl.washington.edu/project/project.php?id=arctic_sea_state

- TerraSAR-X support comprises
- additional SGS contacts used for D/L
- NRT L1b product delivery

- products deliveries for usage at ship Quicklook products in addition with wind and wave charts



Conclusion

- Remote sensing SAR images are more and more in use to support maritime surveillance.
  - Near real time capabilities are amongst others the main requirements for such services.
  - NRT application for SAR processing enables automated fast processing of large volumes of data and information delivery within ~10 to 15 minutes of image acquisition.
- Main tasks for **Solutions for Maritime Situational Awareness** (not complete)
  - Use of multiple information sources to enable integrated maritime picture
  - Data sharing, data fusion and big data handling,
  - High availability of fully automated processing chains
  - Product and interface standardization

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Thank you for your attention !